THE DIAGNOSIS AND TREATMENT OF INTRACRANIAL HEMORRHAGE OF THE NEW-BORN — REPORT OF A CASE *

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Important advances have been made, in recent years, in the knowledge of the causes of intracranial hemorrhages of the newborn, and in the diagnosis of the different varieties. Treatment has also made notable progress in some forms, particularly in those due to a general hemorrhagic diathesis and in those occurring in the posterior cranial fossa. The object of this paper is to attempt to correlate pathology and symptomatology with the various methods of treatment. A case is reported that illustrates successful treatment of a lesion that was correctly localized, as well as needless surgery due to failure to apply all the possible diagnostic methods.

Etiology.—Recent papers by Warwick [1] and Rodda [2] have reviewed the theories of the causes of intracranial bleeding. The hemorrhages may be divided into two main classes, those due to trauma incurred in the passage of the child through the birth canal, and those due to disease of the child. The first class is purely traumatic; the second has no relation to labor, and the most frequent underlying cause is the hemorrhagic diathesis. Green [3] was the first to appreciate the importance of the second factor. Warwick demonstrated the condition in eight of eighteen cases of intracranial birth hemorrhage that came to postmortem examination.

Diagnosis.—An attempt must be made to answer two questions before these cases can be intelligently treated. First, is the intracranial hemorrhage of traumatic origin, or is it one manifestation of the hemorrhagic diathesis? Second, what is the location of the hemorrhage? Neither question can be answered in every case. If the infant shows evidences of multiple hemorrhages, such as a cephalohematoma, petechiæ in the skin, or bleeding from one of the body orifices, the diagnosis of hemorrhagic disease is easily made. But these signs do not always appear. Five of Warwick's eight cases of intracranial bleeding caused by the hemorrhagic diathesis vomited blood, but the other three showed no clinical evidence of the multiple clots that were found post-mortem. Determination of the coagulability of the blood has proved helpful in making the diagnosis. Rodda [4] determined the curve of coagulation and bleeding times in the first few weeks of life, and showed [2] that in hemorrhagic disease of the newborn the times were prolonged.

The second question is of greater importance, for the selection of the proper method of treatment depends on correct localization even more than on differentiation between the traumatic and diathetic types. Seitz' [5] localizing classification is the most useful. He divided the hemorrhages into three groups—the supratentorial, the infratentorial, and the intraventricular. Various combinations are found; thus in Warwick's eighteen cases, six had hemorrhage over one cerebral hemisphere, three over cerebrum, cerebellum and in the dura, three over cerebrum and cerebellum, one over cerebrum, cerebellum and in the ventricle, one over cerebellum, two in the dura alone, and two in the ventricle alone. Her series emphasizes the fact that the most common site is supratentorial, for thirteen of these eighteen cases had hemorrhage over the cerebrum alone or in combination. Cushing [6] called attention to the unprotected pial veins as they travel from the cortex to the longitudinal sinus as particularly liable to injury from overlapping of the parietal bones during parturition. In attempting to diagnose the location of the bleeding, it is proper to consider the odds as in favor of the source being partly, if not entirely, the pial veins that empty into the longitudinal sinus.

The symptoms may be clear-cut and localize the trouble beyond question, but frequently they are confusing, or even misleading. Eliminating those that cannot be resuscitated, most patients cry and appear more or less normal for a time. After an interval of hours or days, symptoms appear. The infant may first refuse the breast, or cry continually, or be drowsy, or show increased reflex excitability, or have sudden attacks of asphyxia with respiratory disturbances. The fontanelle becomes full and tense, and there are convulsions in practically every case. In attempting to evaluate these symptoms it should be remembered that the largely non-medullated brain of a new-born infant makes him little more than a spinal animal, who will live under most adverse conditions provided the medullary centers are not too much implicated. So a large hemorrhage over the cerebrum may give no signs beyond those of increased intracranial pressure, while a small hemorrhage below the tentorium may be rapidly fatal. Disturbances of respiration with cyanosis, generalized convulsions and rigidity of the limbs point to infratentorial bleeding; while convulsions involving first or only one side, or palsies of face, arm, or leg, or lateral deviation of the head or eyes indicate a supratentorial lesion. There seems to be no way to detect an intraventricular hemorrhage from the symptoms.

Spinal puncture gives valuable evidence in localizing the bleeding. When the hemorrhage lies over a cerebral hemisphere the fluid contains little blood, and the withdrawal has no effect on the progress of the case. On the other hand, an infratentorial hemorrhage gives fresh blood, usually in considerable quantity, and removal is frequently followed by temporary or even lasting disappearance of cyanosis, disturbed respiration and convulsions.

Subdural puncture as a diagnostic procedure was suggested by Henschen [7] and, apparently independently, practiced by Gilles [8]. A spinal puncture needle is introduced at the lateral angle of the great fontanelle and passed under and parallel with the parietal bone. Henschen recommended this puncture to confirm the diagnosis of a supratentorial hemorrhage and to prove which side was involved. This is unquestionably a most valuable method, provided it does no harm. If there is a

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subdural clot near the longitudinal sinus, a carefully directed needle need not damage the cortex. But, remembering that the central fissure lies very little posterior to the fronto-parietal suture in the newborn, one wonders whether a negative exploration might not lacerate the motor area. In Case 2 of Green's second paper [9] a negative puncture gave no ill results. Hemorrhage into the lateral ventricles can be confirmed or ruled out by ventricular puncture through the outer angles of the great fontanelle, but this procedure also carries some risk of injuring the motor cortex.

Visual inspection of the dura under the fontanelle after incision of the scalp enabled Murphy [10] to detect clots over the cerebral cortex on both sides of the longitudinal sinus. This apparently neglected method ought to prove of great value, for it avoids the dangers of subdural puncture and requires only a short scalp incision, which may be extended for an osteoplastic exposure on either side.

Three cases reported by Potocki and Levant [11] illustrate the difficulties of diagnosis, even with apparently definite clinical localizing signs, without the help of fontanelle inspection or exploratory puncture. The first two cases showed motor signs pointing to a clot over one cerebral cortex, but both had intraventricular hemorrhage only. The third case had similar signs and was diagnosed hemorrhage into the ventricles, but at post-mortem examination no intracranial hemorrhage of any kind was found. Subdural puncture and fontanelle inspection would have been negative throughout, but ventricular puncture would have made possible a positive diagnosis in the first two cases.

Treatment.—Intracranial hemorrhages have been treated by four methods: (1) spinal puncture, (2) subdural aspiration or drainage, (3) removal of the clot through an osteoplastic window, and (4) measures designed to increase the coagulability of the blood.

(1) *Spinal Puncture.*—This was first proposed and practiced by Devraigne,[12] who reported a case in which the convulsions stopped, leaving the infant in apparently normal condition. Dutreix [13] recorded five cases, of which three recovered and two died following removal of bloody fluid by spinal puncture. Henschen [7] saw that spinal puncture gave good results in infratentorial, but could do not good in supratentorial hemorrhages. Green's [9] Case 1, a typical infratentorial hemorrhage with apnoea, cyanosis, nystagmus and convulsions, cleared up with repeated removals of bloody cerebrospinal fluid and appeared normal on the fourth month. Brady [14] treated three cases with spinal puncture. Two were apparently normal at three years and fourteen months, but the third continued to have convulsions and developed spasticity; post-mortem examination at nine months showed adhesions and flattening over a small area of the cerebral cortex. Foote [15] had six recoveries and one death in infants showing respiratory distress and blueness, with or without convulsive phenomena, treated by spinal puncture and subcutaneous injection of horse serum or thromboplastin. One detailed case was an instance of hemorrhagic disease of the new-born. Good results are also recorded by Lippman [16] and Vaglio [17]. Spinal puncture, on the other hand, has had no influence in numerous cases in which it was used only for diagnostic purposes, and post-mortem examination has usually shown a clot over the convexity of the cerebrum. Thus Rodda's [2] Case 5 had a large hemorrhage over the entire right hemisphere, as well as smaller ones in the pericardium and the spinal canal, and died from intracranial pressure in spite of spinal puncture and repeated subcutaneous injections of whole blood. Rodda recognized that spinal puncture gave results only when the bleeding was below the tentorium.

(2) *Subdural Aspiration or Drainage.*—If aspiration through the great fontanelle is used as a therapeutic measure, it amounts to the same thing as drainage at that point. Gilles [8] so used it, but his patient continued to have convulsions and died at nine months. Henschen [7] advocated it in mild cases, and Green [3] thought that if considerable blood were aspirated operation might be postponed or omitted. Murphy [10] was the first to evacuate a hemorrhage over the cerebral cortex through a short linear incision. He first exposed the anterior fontanelle and saw through the dura evidence of hemorrhage on both sides of the sinus. After turning down an osteoplastic flap and removing the clot, the patient's condition seemed to contraindicate a similar procedure on the opposite side, so the fluid blood was partly evacuated through a short incision lateral to the longitudinal sinus. The infant made a good recovery, and the cerebral condition was considered normal when it died of gastro-enteric disease at five weeks. Simmons [18] added rubber tissue drainage to Murphy's evacuation of a subdural clot through a short incision. He reported two cured cases, one of which gave an excellent result thirteen months after bilateral drainage. He saw the danger of adhesions from the portion of the clot that was not removed, but said that his operation was rapid, easy, and justified by the results. He thought that neither case would have survived Cushing's osteoplastic procedure, which he recognized as the more thorough and desirable method. Green [3] recorded a case so treated by Murphy, in which post-mortem examination showed a clot overlying the cerebral convolutions and extending down into the longitudinal fissure. Cumston [19] and Green [9] have each reported a good result with the Simmons operation. Green felt that incision and drainage gave adequate relief, and was preferable to the osteoplastic operation.

(3) *The Osteoplastic Operation.*—In 1897 Chipault [20] said that the usual clot over the upper motor cortex was a surgical problem, and suggested that its removal would be easy and ought to give good results. Cushing [6] was the first to successfully evacuate a clot through an osteoplastic window. He [21] reported in 1908 that he had thus operated on nine cases, with four apparently perfect recoveries. Seitz [22] and Meara and Taylor [23] reported two cases in which clots over the cerebrum were removed, but both died, and post-mortem examination showed that there was also infratentorial bleeding. Murphy and Torbert [10] had a recovery following evacuation of clots by Cushing's procedure on one side, and through a

short dural incision on the other. Hubbard's [24] case, a fatality, is not easy to classify. He found clots over both cerebral hemispheres, probably through small decompressive openings, and cortical laceration resulted from attempts to enlarge the bone defects. Bailey [25] removed a clot from the motor cortex, but could not suture the dura or bring the bone flap into position because of cerebral herniation. His patient had a facial palsy and a flaccid arm on the thirtieth day. Strachauer [26] has done four craniotomies for cerebral hemorrhage in infants; one died at eight weeks, and the other three were seemingly normal. Rodda [2] reported two of Strauchauer's cases in more detail. One (Case 8) was a typical Cushing procedure, the other (Case 9) was a "decompressive operation," which apparently did not locate the clot, but which was followed by a good result.

The osteoplastic operation has been done fifteen times (Cushing 9, Seitz 1, Meara and Taylor 1, Murphy and Torbert 1, Strauchauer 1, Bailey 1, Towne and Faber 1), with eight recoveries. Two other cases of Strachauer's and one of Hubbard's cannot be classified, because of lack of detail.

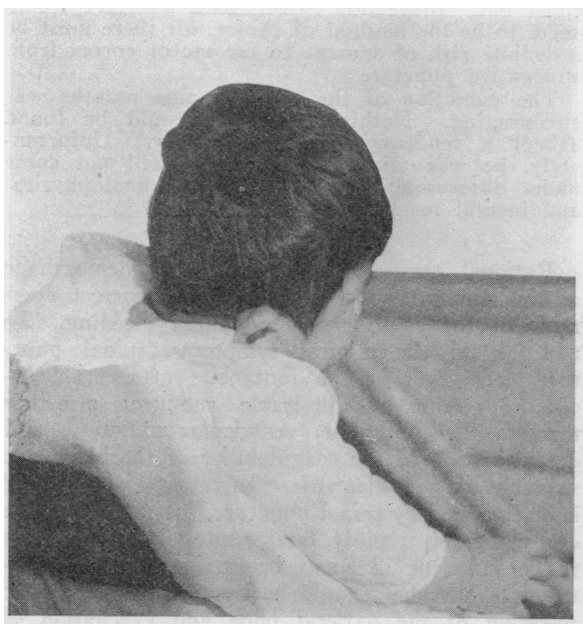

Fig. 1. Lateral view of head at nine months, to show brachycephaly

(4) *Measures Designed to Increase the Coagulability of the Blood.*—Rodda [2] showed that delayed coagulation and bleeding times can be reduced to normal by repeated subcutaneous injection of whole blood, and he felt that this reduction was essential prior to surgical intervention. In two cases successfully operated on by Strachauer, Rodda thought that the blood injections added to the chances of surgical success. Foote [15] had six recoveries in seven cases, treated by spinal puncture and injection of horse serum or thromboplastin.

Case Report.—Male, born July 11, 1920, at full term. The confinement was attended by a Japanese midwife. The mother was in labor ten hours, and delivered herself without assistance. At a later date pelvic measurements, for which we are indebted to Dr. A. V. Pettit, showed moderate lateral contraction of the inlet. The child cried immediately after birth, and was said to be a very strong baby by the midwife. He nursed and appeared well until the third day, when he began to vomit and to refuse nourishment. On the sixth day, July 17, the baby entered hospital as a feeding case.

Examination showed a markedly dessicated infant weighing 2740 gms. The pupils were equal, the eyes and head were turned to the right. The anterior fontanelle was tense and bulging. There was a left facial paralysis, with no motion of the mouth on crying, and inability to close the eyelids. The arms and legs were spastic. Temperature, 98.6°; pulse, 80. That afternoon he had a general convulsion lasting about ten minutes, with cyanosis and rhythmic respiration. On July 18 the pulse was 130, respirations were regular, and the color was good. Attempts to feed with a dropper being unsuccessful, gavage was used. Slight twitching of the left arm was observed twice. A subcutaneous injection of whole blood was given. July 19, spinal puncture gave 2 cc. of straw-colored fluid. Most of the food given by the tube was regurgitated. July 20, the child was somnolent. Aspiration of the left lateral ventricle through the left angle of the fontanelle gave 2 cc. of slightly reddish fluid. Supraorbital pressure did not make him cry, but caused him to move the right face, arm and leg. A diagnosis of hemorrhage over the right cerebral hemisphere was made.

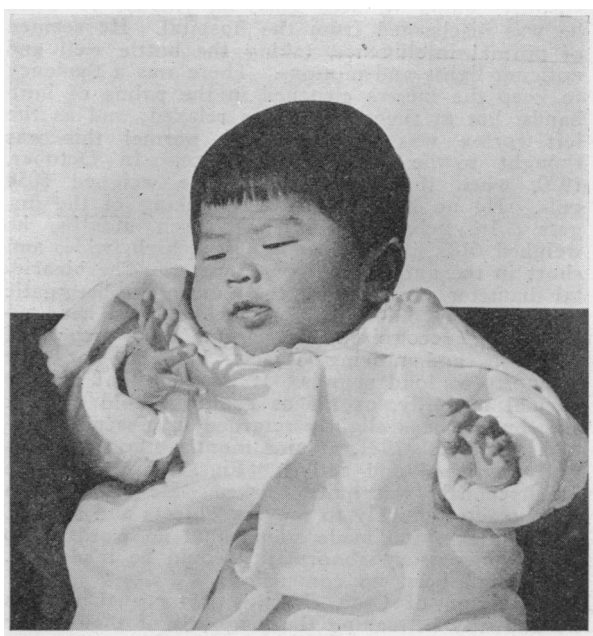

Fig. 2. Appearance at nine months. Note that the finger movements are not restricted

July 21. Operation. The child was wrapped in cotton and lightly etherized. The right parietal bone was turned down in an osteoplastic flap. The dura was tense, immobile and deep blue in color. A flap of dura was reflected and a clot, 1.5 cm. thick, was removed from the cortex with wet cotton swabs and irrigation. The clot extended to the falx, over the frontal and occipital poles and over the temporo-sphenoidal lobe, thinning as midline became more distant. It was partially removed from under the bones with spoon and irrigation. Near the midline and toward the anterior end of the bone opening a large bleeding pial vein was ligated. After removal of the clot the brain still bulged markedly through the opening in the dura. The dural flap could not be brought back into place, and an attempt to swing it up by a plastic incision did not prove successful. The head was lifted off the table with skin clips placed about

the outer margin of the scalp incision. This manoeuvre allowed the brain to drop back into the collapsible cranium so that the dura could be sutured in place. The pericranium and scalp were closed without drainage. Twenty-five cc. of whole blood were given subcutaneously. Following operation the baby began to take his feedings better, and the weight increased to 3200 gms. on July 29. Blood was given subcutaneously on July 22 and 30. The palsy of the left face cleared up rapidly. The conjugate deviation of the eyes, spasm of right neck muscles and rigidity of left arm and leg disappeared gradually, until on July 29 a clenched left hand was the only evidence of right cortical irritation. The spasticity of the right leg and arm showed no diminution. It was thought that a smaller subdural clot lay over the upper portion of the left cerebral hemisphere.

Second operation, July 30. The left parietal bone was turned down, showing a normally colored dura. A small incision at the upper aspect of the defect allowed normal cerebro-spinal fluid to escape. There was no hemorrhage. Closure. In four days after the second operation the right-sided spasm disappeared entirely. He took his feedings well, and after a drop to 3000 gms. he gained weight steadily, going to 3400 gms. on August 19 when he was discharged from the hospital. He seemed of normal intelligence, taking the bottle well and noticing lights and motions. There was a tendency to keep the fingers clenched in the palms of both hands, but at times they were relaxed; and as the left cortex was known to be normal this was thought to be of no significance. In October, 1920, when three months old, he weighed 5050 gms. He no longer showed clenching of the fingers. In February, 1921, at seven months, he weighed 6125 gms. The head was high, wide, and short in the antero-posteror diameter. The biparietal diameter was 12 cm.; the suboccipito-bregmatic 12.5 cm. He did not sit up, or hold the head up well. He recognized his parents, and responded to lights and moving objects, but did not turn promptly to loud sounds. It was felt that he was normal mentally, as far as could be told at that age, but perhaps slightly retarded in muscular control. In April, 1921, at nine months, the child was well nourished and active. (Figs. 1 and 2.) The brachycephaly was quite marked. He played with toys, reacted quickly to moving objects and sounds, sat up alone, and made sounds but no words. No motor or sensory abnormality could be made out. There had been no convulsions.

Discussion of Case.—In this instance there was no difficulty in making the diagnosis of a clot over the right hemisphere, for the symptoms were unusually clear-cut; tense fontanelle, deviation of the head and eyes to the right, palsy of the left face and spasticity of the left limbs, old blood in the cerebro-spinal fluid, and general convulsions. The pathology underlying these signs was accurately forecast, and the only surprising fact was the great size of the clot. The identification of a ruptured pial vein near the longitudinal sinus as the probable source of the bleeding, though noted in Cushing's case 4 at autopsy, has not been previously reported as an operative finding. A matter of considerable technical interest came up in the first operation. Because of bulging of the cortex it was impossible to suture the dural flap in place. Cushing noted this difficulty, but he attributed it to edema of the brain, and advised counteracting it by lumbar puncture. In our case it did not appear possible that lumbar puncture could reduce the tension sufficiently to allow closure. But cerebral edema could have played only a minor role, for the event proved that the cerebral extrusion was largely of mechanical origin. The cranium after closure of the suture lines is a solid box, but in the newborn infant it will collapse if a window is cut through the dura mater. When the baby's head was gently lifted from the table by the edges of the scalp incision the brain dropped back enough to allow closure of the dural incision. It seems probable that this simple manoeuvre will, in other cases, solve the one technical difficulty of the operation. A scalp tourniquet is, of course, inadvisable in these cases.

The second operation did no apparent harm, but it was quite unnecessary. The diagnosis of a clot over the left hemisphere was made on the fact that, though the spasticity of the left leg and arm disappeared rapidly after the first operation, the right leg remained just as rigid as it had been on admission, and the right arm showed only slight improvement. Four days after negative exploration of the left cortex the spastic condition of the right limbs had disappeared. The exploration could not account for this change. A possible explanation may be that on the day before the first operation the lateral ventricle was tapped through the left angle of the great fontanelle. It is conceivable that some slight edema or hemorrhage from this puncture may have temporarily involved the motor cortex for the right arm and leg. Had we been familiar with subdural puncture or inspection of the fontanelle after incision of the scalp, the possibility of a left cortical hemorrhage could have been ruled out. Inspection rather than puncture would seem to be the method of choice, for there must be a definite risk of damage to the motor cortex from a negative puncture.

The condition of the child at nine months was encouraging. Nothing abnormal could be found except a tendency to brachycephaly. Unfortunately, he was taken to Japan and will not come under observation again, so that the final physical and mental result will not be known.

SUMMARY

Rational treatment of intracranial hemorrhage of the newborn must be based on a correct diagnosis of the cause and site of the bleeding. In addition to the clinical symptoms, spinal puncture, inspection of the fontanelle after scalp incision or the less desirable subdural puncture through the fontanelle, ventricular puncture, and determination of the coagulability of the blood are valuable aids in diagnosis. Infratentorial bleeding is best treated by spinal puncture, for a hemorrhage of any size is rapidly fatal, and puncture appears to be sufficient in small hemorrhages. Supratentorial hemorrhage should be treated by osteoplastic resection of the parietal bone and evacuation of the clot. Aspiration or drainage of such hemorrhages does not insure against future trouble from adhesions and cyst formation, and should be used, if at all, only as a preliminary step to the Cushing operation. Spinal puncture and aspiration of the ventricle are indicated in the intraventricular hemorrhages. In all cases, but especially when hemorrhagic disease is diagnosed, subcutaneous, intramuscular or intravenous injection of whole blood, controlled by coagulability tests, should be given. The intracranial clot of the diathetic cases calls for the same surgical treatment as does the clot of traumatic origin. In the case reported a clot over a cerebral hemisphere was diagnosed and removed, but misleading clinical symptoms and failure to inspect or puncture the other side of the fontanelle led to a needless exploration of the opposite hemisphere. Except for brachycephaly, the child appeared normal at nine months. The only technical difficulty of the osteoplastic operation is closure of the dural flap. In our case this was demonstrated to be due to collapse of the skull,

and was easily remedied by lifting the head by the scalp edges, thus allowing the brain to drop back into place. A scalp tourniquet should not be used, for its pressure would increase cerebral herniation through the dural opening.

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OVARIAN AUTOTRANSPLANTATION *

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My experience in ovarian transplantation has been limited entirely to autotransplants and the results in ten cases will be given. The two circumstances under which these operations were performed were:

First: Three cases of hysterectomy with double salpingo-oöphorectomy and transplantation of parts of one or both ovaries into the abdominal wall. In all cases the grafts took and in all cases there has been periodic enlargement and varying degrees of tenderness in the grafts. All cases have had ablation symptoms since operation, but these symptoms have been markedly lessened during the period that the grafts showed activity. These findings are contrary to those of Tuffier, who states that while the grafts increase in size monthly for two or three years after hysterectomy, it is without any benefit to the patient.

Second: Six cases of double salpingo-oöphorectomy without hysterectomy and with autografts from either one or both ovaries into the abdominal wall, and one case of double salpingo-oöphorectomy without hysterectomy with autotransplants into wall of uterus. The justification for leaving the uterus and transplanting the ovaries is: the suppression of pain which follows retained ovaries with damaged blood supply and extensive denudation of the surface of the ovary, permitting adhesions and cystic degeneration and, most important of all, the preservation of menstruation, because that function is absolutely necessary along with ovulation to ensure the patient freedom from the distressing trophic, congestive and nervous symptoms which follow suppression of menstruation.

Surgical Technique: The technique of autografting is simple indeed and adds no extra risk to the operation. In all cases the ovaries were completely removed and the uterine end of the tube resected by a V-shaped incision into the cornua of the uterus. The ovaries were then wrapped in gauze and placed in a vessel containing normal salt solution at about 100° F. The operation and peritoneal toilet were then completed and in some cases a pocket was made, by blunt dissection, between the peritoneum and the under surface of the rectus muscle, on either one or both sides of the incision, according to the number of grafts to be used. The ovaries were then carefully inspected and areas of cystic degeneration were culled out. The remaining ovary, when possible, was cut into disks 2x2x½ cm. and from one to three of these disks were transplanted into the already prepared pockets. No sutures were used to hold the grafts in place. On removing the grafts from the saline solution, one is at first apt to be rather startled at the pale, lusterless and shriveled appearance of the grafts, but this apparently does not interfere in any way with the success of the grafts. The abdominal wall was closed in the usual manner.

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